



Ministry
of Defence

Electromagnetic Spectrum Blueprint

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Foreword

Electromagnetic spectrum (EMS) is a critical resource in warfare. The EMS enables almost every form of command, control, communications, sensing and the concept of Information Advantage, as both a medium for information exchange and an opportunity for information exploitation. For defence capabilities to be globally deployable and agile, the changing global electromagnetic environment (EME) must be considered during acquisition. The EME is recognised as strategic science and technology capability area for the MOD in its science and technology strategy 2017¹. Given its strategic importance, it is vital the MOD retains access to the spectrum it needs.

In the years until 2035, many essential activities in both the military and civil domains will become heavily reliant on mobile communication, each requiring a degree of assured access to the EMS. The military and security services will need to operate alongside allies and civil users in these congested environments without causing accidental disruption. They will also need to operate in austere environments, where the spectrum is much less densely occupied but also less well governed.


Nationally, spectrum access is also becoming congested as consumers demand greater bandwidth and data rates. The government has recognised the growing civil demand and economic value of the EMS and has announced a series of initiatives to capitalise on these. Such developments present defence with the opportunity to drive modernisation in both technology and spectrum regulation by developing frequency agile, spectrally efficient and resilient capabilities, exploiting enhanced spectrum planning processes and improving responsiveness to regulatory spectrum risks. These will allow defence to achieve mission success now and in the future.

The digital and information technologies (D&IT) strategy² recognises the need to improve coherence through an enterprise approach. Cyber and electromagnetic activities (CEMA) are interdependent and within the electromagnetic environment. Through embracing D&IT and CEMA, we can make better use of the specialist skills we have within the MOD, working towards common, co-ordinated and, where appropriate, synchronised outputs.

This blueprint sets out three goals to address these challenges, which aim to field efficient, adaptable and resilient systems, improve the effectiveness of spectrum usage planning, and respond effectively to spectrum regulatory and policy changes.


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Dated: 20/8/19


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Claire Fry

Dated: 20/8/19

¹ <https://www.gov.uk/government/publications/mod-science-and-technology-strategy-2017>

² <https://www.gov.uk/government/publications/digital-and-information-technologies-strategy>

Vision

Defence Spectrum Dependent Systems to be globally deployable and responsive to the changing Electromagnetic Environment

Executive Summary

1. All defence operations, whether on land, at sea, in the air, in space, or in cyberspace, are fundamentally dependent on the use of the EMS. All joint functions – movement and manoeuvre, fires, command and control, intelligence, surveillance, reconnaissance, protection, sustainment, and information – are achieved, or optimised, using capabilities that need access to the EMS. To protect our people, project our global influence and promote our prosperity³, defence depends on spectrum access more than ever before.
2. Defence’s demand for spectrum access is increasing due to the growth in complexity of modern military systems, and the demand for greater and more timely information at every level of command. Meanwhile, peer and near-peer adversaries have significantly developed their abilities to operate and control the EME, leading to a greater contest for spectrum access.
3. Realistic training for operations is vital in underpinning operational success and is critically dependent on timely access to enough suitable spectrum for the required service/capability. Accordingly, the overriding requirement for this blueprint is for defence to have sufficient, flexible spectrum access, now and into the future.
4. Spectrum demand in the civil sector is also increasing, due to the growth of wireless technologies and the expectation of higher data rates. These competing spectrum drivers lead to global spectrum congestion, which will only increase year-on-year. To address this, Prime Minister David Cameron declared a vision through the UK spectrum strategy⁴ in 2014 to double spectrum’s annual contribution to the economy and this ambition has not changed. The current public sector spectrum release programme (PSSRP) target was announced in the 2016 Budget⁵:

“750 MHz of valuable public sector spectrum in bands under 10 GHz will be made available by 2022, of which 500 MHz will be made available by 2020”

5. This blueprint sets out three goals and associated objectives for the approach defence will take to ensure enough spectrum access to achieve mission success, while contributing to the UK spectrum strategy and PSSRP target:

³ National Security Strategy and Strategic Defence and Security Review 2015

⁴ Published on 10 Mar 14 by the Department for Digital, Culture, Media and Sport:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287994/UK_Spectrum_Strategy_FINAL.pdf

⁵ 7.49 Digital Policy Decisions - <https://www.gov.uk/government/publications/budget-2016-documents/budget-2016>

- **Goal 1: Fielding efficient, adaptable and resilient Spectrum Dependent Systems:** the MOD will develop and field Spectrum Dependent Systems (SDS) that are suitably efficient, adaptable and resilient in their spectrum usage, as appropriate to their application and anticipated operating environment
- **Goal 2: Effective planning and risk management:** the MOD will develop its ability to plan its spectrum use and manage spectrum risks in both the home base and deployed environments
- **Goal 3: Effective response to regulatory and policy changes:** the MOD will develop its ability to respond effectively to spectrum regulatory and policy changes by proactively engaging with the national regulator (Ofcom), CEPT⁶, NATO and 5 eyes partners so defence requirements are understood and taken into consideration when national, european and international regulatory decisions are made

Mission

Enable enough, flexible spectrum access to achieve mission success now and in the future

Introduction and Scope

6. This blueprint provides the direction for current and longer-term initiatives to ensure that defence has the battlespace and business-space spectrum access required to meet its standing tasks and operational commitments, while meeting defence's contribution to the PSSRP target. It complements the:

- **Future Force Concept**⁷, which recognises the importance of understanding and using the EMS, and ties this into the cyber domain
- **CEMA concept**⁸, which will enable MOD to analyse and set project requirements in the EME in support of wider defence objectives and identify any opportunities of existing capabilities in the SIGINT, cyber and networking, or electronic warfare specialisms which may have otherwise been unavailable for spectrum management and EME analysis – to support the CEMA concept, a Policy paper has been developed by Joint Force Command which sets out the EMA vision for defence⁹ and how CEMA should be met

7. This blueprint sets out three goals and underpinning objectives to be met through to 2035 to achieve the vision and mission statements. To support its implementation, a governance structure will be developed along with a road map, the latter providing the actions, associated lead organisations, estimated costs, schedule, deliverables and metrics needed to implement and

⁶ The European Conference of Postal and Telecommunications Administrations (CEPT) is responsible for co-operation on commercial, operational, regulatory and technical standardisation issues. Within the CEPT the Electronic Communications Committee (ECC) develops common policies and regulations in electronic communications for Europe. Its primary objective is to harmonise the efficient use of the radio spectrum, satellite orbits and numbering resources across Europe. Further information can be found at www.cept.org

⁷ JCN1/17, Future Force Concept, <https://www.gov.uk/government/publications/future-force-concept-jcn-117>

⁸ JDN 1/18, Cyber and Electromagnetic Activities, <https://www.gov.uk/government/publications/cyber-and-electromagnetic-activities-jdn-118>

⁹ UK Defence Electromagnetic Activities Policy dated 1 Aug 18

monitor the achievements of the goals and objectives. The road map will also address other underlying defence lines of development (DLOD) activities needed, such as raising awareness of the importance of spectrum and the demands that may influence its continued use. The road map will be updated annually in line with the defence spectrum policy¹⁰, to reflect lessons learned, improvements made and changes in MOD EME business and battlespaces. As a starting point, the road map schema is presented at the end of this blueprint.

The Evolving Spectrum Environment

8. Operating effectively in the EME has long been recognised as a critical enabler for military success: it also presents significant challenges that can place defence at operational risk. Anticipating and adapting to changes within the EME is critical for operational advantage and for freedom of action to be maintained and exploited. To “train as we fight”, both in the UK and overseas, will be similarly constrained as the growth in civil demand for the spectrum increases globally to meet consumer expectations.

9. Spectrum demand from defence and our coalition partner SDS systems is growing and these advances in technology are also being adopted by potential adversaries which will make the EME even more congested and contested. This demand is driven by the need for improved:

- situational awareness
- intelligence
- unmanned vehicles
- data rates
- target detection at greater distances

10. In 2014, Ofcom published its mobile strategy,¹¹ which states: “use of mobile data services brings considerable benefits to UK citizens and consumers and demand for these services is likely to increase significantly in the future. One estimate is that demand for mobile data in 2030 could be 45 times higher than today, with the traffic carried on mobile networks (after allowing for traffic offloaded to wifi networks) increasing 25 times. Addressing this demand is a priority area for Ofcom over the coming 10 years.” This illustrates the rapidly increasing demand from the private sector, particularly in the ‘sweet spot’ below 6 GHz. Given the buoyant smartphone market and the growing trend for machine-to-machine interactions, internet of things and the increased bandwidth requirement for 5G, the demand will only increase. Consumer demand for spectrum will continue to increase and is rapidly changing the EME landscape both nationally and internationally. As technology matures, defence-managed spectrum will come under increased pressure to fulfil commercial spectrum demand. Ofcom is looking at the high frequency (HF) band for the provision of narrow and wideband applications. This has been achieved through technological breakthroughs in equipment development that have made the band attractive. Defence needs to embrace the new wideband technologies coming to the market to fulfil defence capability requirements.

¹⁰ JSP 604, Part 1, Volume 1, Section 9 – Governance for the management and use of the Electromagnetic Spectrum. (Wiki version is hosted on the Defence Manual for ICT Wiki)

¹¹ https://www.ofcom.org.uk/data/assets/pdf_file/0027/58347/Mobile-Data-Strategy-statement.pdf

Government Response

11. The government has ambitious plans to release or share¹² public sector spectrum. This target is a total of 750 MHz below 10 GHz by 2022, with 500 MHz below 6 GHz of which being released before 2020. Defence as the largest public-sector user of the spectrum has a part to play in meeting this government target. Spectrum regulators around the world are also targeting public sector spectrum to meet growing civil demand. Defence will need to work toward vacating frequency bands identified for release (where possible without effecting defence capabilities) and sharing spectrum in the bands it retains through better understanding and efficiency in the use of spectrum. This is being enabled through concentrating on efficiency and agility in our approach to spectrum usage to enable us to retain, or have access to, enough spectrum to achieve mission success both in the UK and globally.

Defence Response

Defence will develop frequency agile, spectrally efficient and resilient capabilities, supported by using enhanced spectrum planning, monitoring and improved responsiveness to regulatory spectrum changes

12. The UK government is being challenged to make decisions that balance defence and security against economic growth. The UK spectrum strategy¹³ articulates that spectrum is a valuable resource, and a 2012 report valued the contribution to the UK economy at £52 billion per year. The government's vision is to double that contribution by 2025 through providing the private sector with the spectrum access it needs to innovate and grow.

13. An understanding of the EME, including spectrum access requirements, underpins all electromagnetic activities (EMA) across defence, such as offensive, defensive, inform and enabling activities. There is a move within defence to further a common understanding, oversight and governance for these areas to allow better control and exploitation of the EME, pulling together spectrum management, electromagnetic environmental effects (E3), electronic warfare and cyber activities. The development of better spectrum management, real-time sensing and spectrum monitoring tools will assist in allowing defence access to the EME.

14. While the UK has been concentrating on stabilisation operations for the last decade, peer and near-peer adversaries have been significantly developing their abilities to operate in the EME. Therefore, defence should expect to have their SDS degraded, or at times denied, while having to maintain the ability to achieve the operational advantage at the required time and place. Accordingly, the ability to perform successful electronic attack manoeuvres, while our own capabilities from adversaries, is crucial.

15. The strategic defence and security review 2015 (SDSR15)¹⁴ stated defence must "invest in agile, capable and globally deployable Armed Forces and security and intelligence agencies to protect the UK and project our power globally". Many of these capabilities require spectrum access – part of the response to SDR15 is an increased investment in intelligence, surveillance targeting,

¹² 'Release' meaning that the government stops using radio frequencies and allows the public sector to use them, and 'share' meaning to allow the public and the government to use frequencies concurrently in ways which minimise interference.

¹³ Published on 2 Nov 12 by DCMS, based on a study by Analysis Mason: <https://www.gov.uk/government/publications/impact-of-radio-spectrum-on-the-uk-economy-and-factors-influencing-future-spectrum-demand>, accessed 14 Sep 18.

¹⁴ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478933/52309_Cm_9161_NSS_SD_Review_web_only.pdf, accessed 14 Sep 18.

acquisition and reconnaissance capabilities which are heavily reliant on the use of spectrum. For these capabilities to be globally deployable and agile, the changing global spectrum environment must be considered during acquisition and through life.

16. SDSR15 also recognised that defence will most likely be involved in humanitarian assistance, counter terrorism operations and operations to restore peace and stability, and as such there is a need to work with host nations. It must therefore be assumed that host nation infrastructures will remain intact, and in operation, when considering battlespace spectrum management plans. SDSR15 also stated that we should expect to deploy with allies or as part of broader coalitions, so interoperability of SDS will continue to be a key high-level requirement.

Public Sector Spectrum Release Programme

17. In March 2011, the Defence Minister endorsed the DCMS paper ‘enabling UK growth – releasing public spectrum’ agreeing to make 500 MHz of spectrum available by 2020. In the Budget statement of 2016, it was announced that the target be increased to 750 MHz by 2022.

18. The PSSRP was created by Her Majesty’s treasury (HMT) to formalise spectrum reforms in the UK. Defence as the largest user of public sector user signed up to this initiative. HMT has also set out a policy to incentivise government departments to release or share the spectrum they manage known as administrative incentive pricing (AIP), which sets out the opportunity cost for the frequency bands departments use. This cost is calculated on a frequency band basis by Ofcom using current licence fees and recent spectrum awards. Ofcom recommends to HMT how much each frequency band is worth and how much each department should pay annually to retain access to the spectrum.

19. The MOD is committed to meeting the PSSRP target, sharing approximately 85% of the frequency bands it manages with other users, including other government departments and the civil sector. It has already released or shared a significant amount of spectrum and is proactively working with the government to seek further opportunities. Sharing or release should be considered where there is a clear civil demand, the effects of civil access to MOD-managed frequency bands can be managed and the benefits of civil access to the UK outweigh the costs to MOD. The outright release of the EMS is a costly, complicate task in an environment where there is increasing demand for spectrum from SDS, so the focus is now on spectrum sharing. Each frequency band will have challenges which must be investigated before any decisions are made as activity in one frequency band may affect adjacent bands. An holistic approach must be used to minimise unintentional interference to incumbents and adjacent users and civil users may be constrained in the UK to allow military SDS to operate.

20. The results of the work already completed by defence is set out in the table below:

Band	Quantity	Year	Released or shared?
870-872 MHz 915-917 MHz	4 MHz	2014	Released
2025-2070 MHz	45 MHz	2015	Shared
Upper 2.3 GHz (2350-2390 MHz)	40 MHz	2015	Released
3.4 GHz (3410 – 3600 MHz)	190 MHz	2015	Released
5.7 GHz (5725 – 5850 MHz)	125 MHz	2017	Shared
7.9 – 8.4 GHz	168 MHz	2019	Shared
Total	572 MHz		

21. Other departments have contributed 105 MHz to the target so far:

- Home Office has released 13 MHz
- Civil Aviation Authority has shared 92 MHz

22. The government's total to date is **552 MHz**, the difference of 125 MHz from the above figures reflects the adjustment for shared bands available for civil use.

23. The PSSRP has identified the following priority bands to further contribute to the government's target. These frequency bands are currently under review for sharing opportunities:

Band	Quantity
380–385 MHz 390–395 MHz	Up to 10 MHz
406–430 MHz	Up to 5 MHz
1427–1452 MHz	Up to 25 MHz
2.3–2.35 GHz	Up to 40 MHz
2.7–3.1 GHz	Up to 200 MHz
4.8–4.99 GHz	Up to 100 MHz
5.350–5.470 GHz	Up to 60 MHz

24. Changes in use of the EMS are being made within the marketplace and industry. Defence needs to monitor these to understand the way potential sharers operate and take advantage of such innovations for defence use. There are numerous innovation work strands underway highlighted in the innovation road map currently under development by the spectrum team. These work streams will evolve as they are trialled and tested as defence strives to achieve this blueprint.

Governance

25. The competing demands for spectrum access are governed by national and international regulations. The UK is not alone in decreasing its public sector share of spectrum: governments worldwide have recognised the economic value of the EME and therefore defence's SDS will experience a range of restrictions and constraints. The changing global EME must always be considered during defence acquisition decision making and capability planning.

26. Figure 1 below summarise how the EMS is governed internationally, nationally and within the MOD.

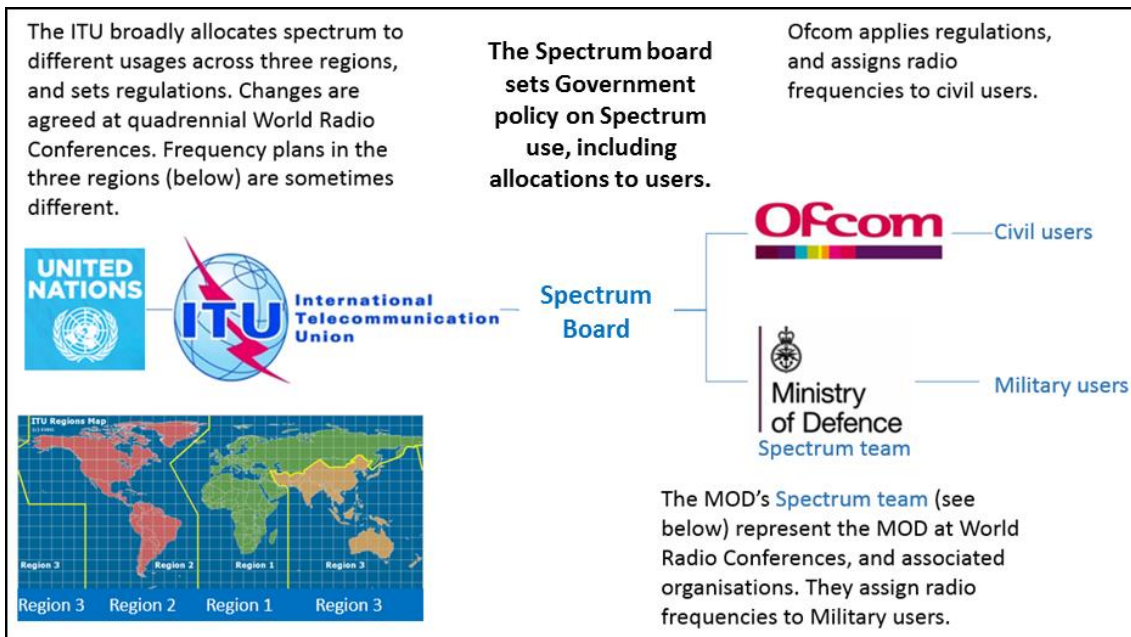


Figure 1 – Overview of Spectrum Governance in the UK

27. Spectrum is divided into frequency bands, which are subdivided for various services: for example, mobile, maritime, aeronautical and satellite services. It is the responsibility of national regulators to interpret the regulations agreed at the international telecommunications union (ITU¹⁵) to minimise the risk of interference. In the UK, Ofcom manages the spectrum in accordance to the regulations and sets out national use in the UK frequency allocation table (UK FAT¹⁶).

28. The UK FAT sets out:

- what service is allowed in each frequency band
- which service has primacy, and which has a secondary status
- which department has management rights
- co-ordination agreements between departments and the private sector
- national/international footnotes that detail technical constraints
- national tables are based upon the international radio regulations set by the ITU

¹⁵ The roles and responsibilities of the ITU, a body of the UN, can be found at <https://www.itu.int/en/ITU-R/information/Pages/default.aspx>

¹⁶ <http://static.ofcom.org.uk/static/spectrum/fat.html>

29. Spectrum governance in the MOD is managed by the spectrum team:

- the spectrum policy team is responsible for all spectrum policy engagement with Ofcom, government departments, international partners and defence users of the EMS and is also responsible for meeting the PSSRP targets
- the joint spectrum authority (JSA) manages defence's spectrum usage in the UK and are also responsible for the clearance of spectrum for all operations, exercises and overseas visits
- the electromagnetic environmental effects authority (E3A) team is a tri-service head of specialisation (HoS) responsible for the outputs associated with E3 – E3A offers functional assurance, policy, advice and guidance throughout the acquisition cycle on all aspects of electromagnetic compatibility (EMC), mutual interference (MI), electronic emission security (ELSEC), radio frequency radiation hazards (RADHAZ), electromagnetic pulse protection (EMPP) and technical attack countermeasures (TAC)

30. Figure 2 below depicts the virtual spectrum team within defence:

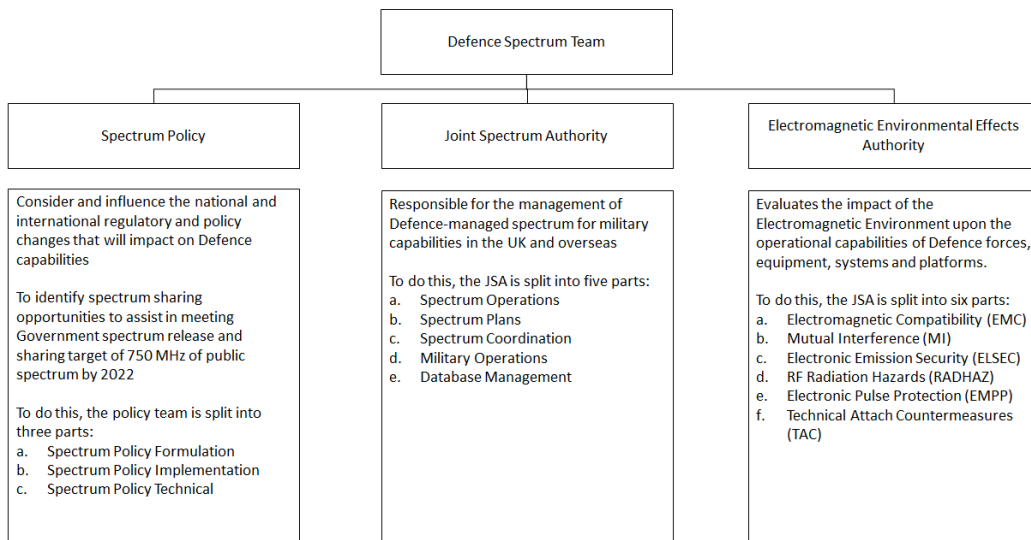


Figure 2 - Defence Spectrum Team

31. Figure 3 below shows the CADMID acquisition life cycle governance points (similar decision points exist in other acquisition life cycles). Those involved in the acquisition must engage with the JSA at the earliest opportunity to ensure SDS are designed, implemented and operated in the most spectrally efficient way.

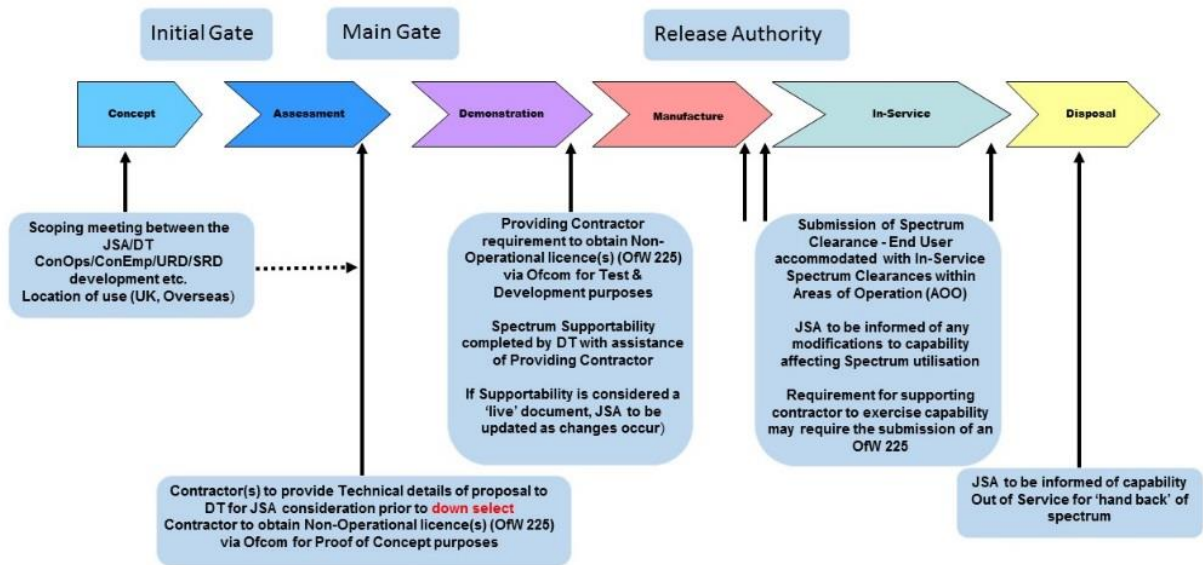


Figure 3 - CADMID Cycle describing the interaction with the JSA at each stage

Goals and Objectives

Goal 1: Fielding efficient, adaptable and resilient SDS

The MOD will develop and field SDS that are efficient, adaptable and resilient in their spectrum usage, as appropriate to their application.

Objective 1.1: Drive technological innovation

- defence will drive technological innovation to assure spectrum access in an increasingly congested and contested EME
- to meet the MOD's growing spectrum demand in the context of reduced exclusive access, defence will encourage the research and development community and industry to develop and exploit new technologies that use spectrum more efficiently, that are flexible and agile, but also are resilient to interference – such technological developments will minimise the effect on the EME, help assure SDS can access spectrum in different and changing EMEs and will increase spectrum sharing opportunities while maintaining radio frequency interoperability, safety, security and protection
- to achieve this efficiency, defence needs to champion, where appropriate:
 - the use of transmitters and receivers that can access wider frequency ranges
 - the exploitation of spectrum efficiency gains
 - the use of less congested bands
 - the use of spectrum bands on a dynamic, opportunistic basis
 - solutions resilient to interference
 - the ability to be adaptable to a rapidly changing EME
- the MOD will also exploit technological advances to access less used spectrum bands and will explore increased spectrum sharing technologies and methodologies – the EME is recognised as one of the strategic science and technology capabilities which contributes towards defence and security, and as such is one of the eleven capability areas underpinning the science and technology capability framework
- defence will use civil sector innovations where possible, for example smartphones and next generation wireless communications services, including those available on a global and local basis, where service access and security can be guaranteed through using techniques such as virtual private networks – the MOD will evaluate the viability of these and other emerging commercial hardware, applications, operating systems and services for operational use
- defence will participate in national, international, and industry sector specific standards bodies associated with SDS innovation to work on, and influence the development of emerging technologies and their potential adoption into service – such engagements may best be through Dstl or defence industry partners and will benefit MOD operations and the defence budget and could have positive effect to the wider UK economy

Objective 1.2: Strategically review opportunities to upgrade SDS mid-life

- the MOD should use any opportunities provided to upgrade SDS mid-life, for example, when upgrading equipment co-located to SDS, or when re-fitting vehicles, to replace or tune the equipment to be more flexible, efficient and resilient
- such opportunities should also be used to verify that the SDS and other equipment that interacts or influences the EME has been scoped by the E3A as either a contractual deliverable or assessed under MOD trials and its specifications have been registered with the JSA and, if applicable, the authority to radiate has been given

Objective 1.3: Modify and influence policies, regulations and standards

- defence will modify and influence policies, regulations and standards to enable MOD capabilities to exploit technological developments that allow flexible and dynamic spectrum access and aid spectrum sharing
- defence, national, and international policy and regulatory changes are needed to allow dynamic, opportunistic spectrum access, including MOD access to spectrum allocated in the UK for non-military use – the MOD will identify and evaluate incentives for spectrum sharing while developing spectrum policy (spectrum rights, MoU's and service level agreements) to share spectrum through agreements and on a demand and risk-assessed basis and will include amending spectrum legislation and greater engagement with industry and other government departments where necessary

Goal 2: Effective planning and risk management

The MOD will develop its ability to plan its spectrum use, and manage spectrum risks, in both the home base and the deployed environment.

Objective 2.1: Improve the quality, quantity and usability of data held about SDS

- the maintenance of comprehensive spectrum data repositories that support the use of spectrum is vital for the accomplishment of all three goals – the MOD must improve its ability to identify and model the spectrum footprint of SDS at any point in time, which requires an improvement in the quality and quantity¹⁷ of data, and a secure, user-friendly database
- the JSA must be informed of changes to SDS throughout the acquisition lifecycle regardless of the process being followed: CADMID¹⁸, a rapid development cycle, COTS/MOTS¹⁹ solutions or UCR²⁰ – it is also important for end user teams to continue to talk to the JSA when there is a change in usage, midlife upgrade or when the SDS goes out of service

¹⁷ Meaning how well the data held reflects totality of real-life SDS owned and/or operated by the MOD or authorised for use by the MOD. The database would, ideally, hold up to date, accurate, error-free data for every data field, for every SDS (including receivers and transmitters).

¹⁸ Concept, Assessment, Development, Manufacture, In-service, Disposal.

¹⁹ Commercial/Military Off-the-Shelf.

²⁰ Urgent Capability Requirement.

Objective 2.2: Further develop the MOD framework for capability planning

- the MOD will work towards adopting formal spectrum standards and protocols and establishing policy that any investment appraisal²¹ must consider spectrum sharing, efficiency, flexibility and adaptability as part of its assurance process – this will be achieved by consideration of a capability's spectrum footprint being recognised as a factor in option selection, like existing C-SWAP²² considerations
- spectrum services will be made available via the ISS Service Catalogue, to enable MOD users to demand spectrum services in a consistent and repeatable way – these services will be offered in categories and will be supplied via the appropriate funding model to enable effective fulfilment of the demand with the longer-term intent to enable users outside of MOD to be able to demand our services in a similar vein
- defence needs to have a greater understanding of its future spectrum requirements in the EME so that spectrum risks can be better managed, both in battlespace management and in spectrum sharing decisions at the highest level of government – the MOD will improve its oversight of spectrum use at the operational level to ensure spectrum availability risks are identified and managed at the early stages of SDS capability planning, development and procurement
- the MOD will expect top level budget ownership of risks associated with the functioning and safety of SDS – through the spectrum team, the MOD will improve understanding of spectrum access risks and associated future costs, to ensure continuity of spectrum access is an important design consideration in capability development
- the MOD will ensure future systems align with this blueprint and are registered with the JSA and the JSA will support capability teams to understand future spectrum needs, allowing forward planning for reclaiming currently shared spectrum, guiding national or international regulatory changes if required, or identifying suitable alternative approaches – defence will therefore identify, encourage and maintain oversight of research being undertaken by Dstl on spectrum related topics.

Objective 2.3: Develop the ability to perform near-real-time spectrum operations

- defence will develop the ability to perform near-real-time spectrum operations in both the home base and the deployed environment
- the MOD should also improve situational awareness of the EME and needs to consider the aspects of spectrum monitoring that are required to underpin near-real-time spectrum operations, and how to resource this function – more generally, the MOD needs to fully consider and understand the wide range of spectrum monitoring tools that are available and more fundamentally what the requirement is to support spectrum superiority
- future adversaries will have the technical ability to disrupt our use of the EME through the deployment of advanced tools and procedures in a co-ordinated manner and, therefore, an understanding of potential adversaries' capabilities through various means, including spectrum monitoring and understanding how they are deployed, is vital for mission success – the MOD will be able to assemble mission-tailored capabilities and supporting tools that meet commanders' requirements in real-time, with a drive to enable spectrum freedom of

²¹ JSP 655: Defence Investment Approvals - <http://defenceintranet.diif.r.mil.uk/Reference/DINsJSPs/Pages/JSP655.aspx>, accessed 14 Sep 18

²² Cost, Size, Weight and Power requirements.

manoeuvre, and ensure SDS compatibility and adaptability within the continuously changing, congested and contested EME

- the MOD must develop the tools and techniques required to quantify spectrum requirements and assess the EME into which they must deploy – the MOD will develop the ability to use this information to identify and mitigate spectrum issues and limitations that could affect operations
- the MOD should develop a policy-based management system or system-of-systems to control SDS parameters (eg signal coding, power) as a function of near-real-time location to meet mission performance requirements while also preventing harmful interference (and potentially making detection by adversaries more difficult) – user requirement documents must recognise the need to publicise more efficient use of the EMS, considering the need for spectrum agility, wider tuning ranges, good receiver performance as well as selectivity when compiling key user requirements: efficiency-related user requirements must not be trade out during the lifecycle of projects

Objective 2.4: Improving E3 requirements and SDS risk mitigation

- the E3A must manage their equipment holdings in such a way as to enable timely procurement of testing facilities that keep pace with new-to-market, modern capabilities and these facilities must be future proof where possible to enable upgrades that keep pace with rapidly evolving and innovative ways of using the available spectrum that will be employed by emerging technologies – these include developing operating frequency bands, modulation techniques, antenna design technology and security requirements
- the E3A provides both contractual and legal advice and guidance to acquisition teams across the Defence Equipment and Support (DE&S) organisation and the front line commands – E3A also undertake practical assessments where an in-house MOD facility is either more cost effective or the security classification of the system dictates, covering:
 - RADHAZ
 - EMC/Mutual Interference
 - Telecommunications Electronics Material Protected from Emanating Spurious Transmissions (TEMPEST)
 - Technical surveillance countermeasures
 - Electromagnetic Pulse Protection
 - the sponsor of several E3 focused defence standards and provide the UK's input to equivalent NATO STANAGs
- it is vital that E3A have the capacity and funding to ensure that they maintain pace with developing SDS and technical readiness levels to maintain the defence E3 capability – the maintenance of modern standards, equipment and a suitably qualified and experienced person workforce is vital to allow for the planning and execution of theoretical and practical assessments that measure compliance against modern UK MOD & NATO standards
- where testing against contractual requirements dictates the use of commercial test facilities, these facilities would need to plan their test equipment procurement strategy in-line with the advances in technology and upgrades to capability

Goal 3: Effective response to regulatory and policy changes

The MOD will develop its ability to respond effectively to spectrum regulatory and policy changes by proactively engaging with the National Regulator, CEPT, NATO and 5 eyes partners so that defence requirements are understood and taken into consideration when national, european and international regulatory decisions are made.

Objective 3.1: Reform the MOD's ability to assess regulatory proposals

- the MOD must improve its ability to quantify spectrum requirements of current and planned military capabilities, it should develop:
 - a forward look of near to medium term (0-10 years) SDS and future military tasking to be able to assess the effect on operations (including training) quickly of any potential changes to global spectrum harmonisation and use
 - cost assessment frameworks to evaluate costs associated with spectrum remediation through life and use these to balance these costs with increased development costs for more spectrally agile equipment
 - tools and processes to decrease the time it takes to assess technical, operational and financial effects of regulatory changes to MOD spectrum should also be developed
- Although improvements to SDS and spectrum operations carried out under Goals 1 and 2 will eventually reduce the effect of regulatory and policy change on the military, the MOD will continue to assess the worldwide regulatory and policy changes being proposed to understand their effect on defence spectrum access
- The spectrum team must notify those who are developing concepts or delivering equipment at the earliest opportunity of any regulatory changes being considered or implemented that could affect the continued access to the EME – by doing so, new capabilities will be able to react to changes and operate as planned throughout their life cycles without the need for costly in-service remediation activities and such assessments include quantifying the technical, financial, and operational implications of SDS remediation: this activity is led by the spectrum team with SME support as required

Objective 3.2: Expand MOD contributions to regulatory and policy discussions

- The MOD will proactively engage with national and international decision forums, developing alternative regulatory and policy solutions to mitigate the effects of such decisions on MOD capability, putting forward compelling arguments to augment its access to the spectrum in the future where necessary
- The MOD must continue to actively participate in the national and international spectrum arena so that defence requirements are understood and protected when binding decisions are being discussed and involvement in the world radiocommunication conference (WRC) process in support of Ofcom is vital so that defence needs are understood and taken into consideration – defence will work with coalition partners such as NATO, the european defence agency (EDA) and the combined communications electronics board (CCEB), so spectrum regulatory risks can be understood and mitigated across the world

- from a national security perspective, the MOD must not experience a degradation of capability because of regulatory and policy changes and the programmes to implement any wider government directed changes must be realistic and acceptable to defence – this will require the MOD to work closely with Ofcom and across government, to increase their understanding of MOD operational requirements and the potential effects of any regulatory changes, see Figure 4 below for an indication of the decision process:

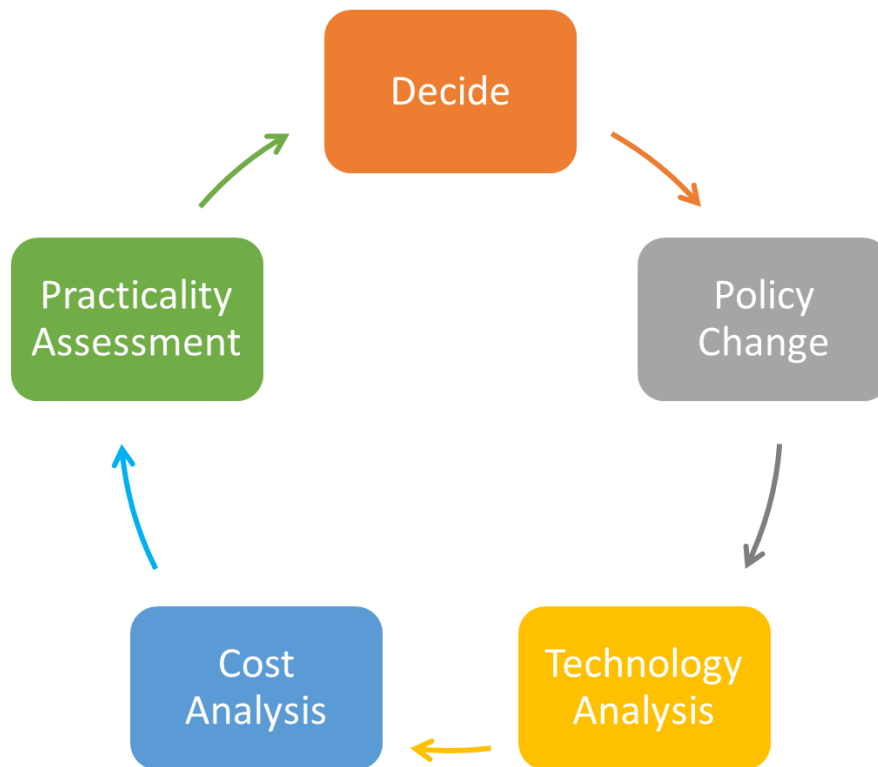


Figure 4 – Decision process for assessing and supporting the changes in spectrum regulations

Road Map

32. The schema overleaf introduces the road map defence needs to embark on so that continued and future use of the EMS is guaranteed both in the UK and during deployments overseas. The road map will be developed over the next year to articulate what needs to be done to meet the goals and objectives set out in this document.

Road Map Schema

